

Shoot drying and its cause in *Calamus simplicifolius* at Nanmeiling, Hainan, China

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Received: 2010-11-22; Accepted: 2011-03-01
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Abstract: Many stems are subject to shoot drying in the plantations of *Calamus simplicifolius* Wei at the Nanmeiling Base of the Forestry Bureau of Baisha County, Hainan Province. As a palm, stems of *C. simplicifolius* stop growing and later die if the shoots are dry. Generally, shoot drying means reduced cane production and reduced profit for a rattan plantation. We aimed to quantify the incidence of shoot drying and determine its reason. We sampled eight 20 m × 20 m plots in the *C. simplicifolius* plantations. In each plot, we counted stems and categorized them as drying shoot or normal shoot, and mother stem or sucker stem. We measured stem length and categorized them as drying shoot and normal shoot for mother stems. We cut open each shoot-drying stem to determine the cause of drying from drying part to fresh part. The frequency of mother stems (259 stem·ha⁻¹), was significantly lower than sucker stems (588 stem·ha⁻¹). The percentage of shoot drying was 33.8% for mother stems, not significantly higher than that for sucker stems (18.9%). The mother shoot stems were significantly shorter if they were drying than if normal. 80% of stems with a drying shoot were hollow within the leaf sheath, whereas 10% hosted lively mature larvae (one larvae per shoot) and 10% hosted several lively young larvae. Mature larvae were identified as the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliver. To confirm the present of the weevil, three pheromone traps for the weevil were set up in the plantations and adult weevils were trapped on the next

day and identified as the Red Palm Weevil. We conclude that shoot drying of *C. simplicifolius* is probably caused by the Red Palm Weevil.

Keywords: *Calamus simplicifolius*; rattan; shoot drying; Red Palm Weevil; *Rhynchophorus ferrugineus*

Introduction

Calamus simplicifolius Wei is an indigenous rattan species in Hainan Island, P. R. China (Pei et al. 1991). Its canes are pliable and durable and have a long utilization history in Hainan Island. *C. simplicifolius* has been cultivated throughout southern China for decades for its superior canes. Established plantations of *C. simplicifolius* are estimated to occupy more than 1 000 ha, most of which are located on Hainan Island (Li et al. 2007).

As a palm, the stem of *C. simplicifolius* stops growing and later dies if its shoot is drying. Generally, shoot drying causes reduced cane production and reduced profit for a rattan plantation. Increasing numbers of stems appear subject to shoot drying in the plantations of *C. simplicifolius* in the Neimeiling Base of the Forestry Bureau of Baisha County of Hainan province. Therefore, corrective management is needed to control the spread of shoot drying. Our study objective was to quantify the incidence of shoot drying and determine its cause to prepare plans for corrective management.

Materials and methods

The investigation site

The investigation was conducted at the Nanmeiling Base of the Forestry Bureau of Baisha County of Hainan Province of P. R. China. The base is located in central Hainan Island, ca. 20 km southeast from the county seat of Baisha County (Fig. 1). The site is vegetated with native secondary forests and plantations of *Pinus caribaea* and *Acacia mangium* that were established in the

Foundation project: This research was supported by the projects of formulate Regulations for the Cultivation of Rattans (No.2009-LY-097) and Guidelines for the Conduct of Tests on Distinctness, Uniformity and Stability for *Calamus* Plants (No.2009006).

The online version is available at <http://www.springerlink.com>

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Responsible editor: Yu Lei

early 1990s. Three indigenous rattan species, *C. simplicifolius*, *C. tetradactylus* and *Daemonorops margaritae*, were planted under the secondary forests and plantations from 2001 to 2005.



Fig. 1 Location of the Nanmeiling Base of Baisha County in Hainan Island

Sampling

In July 2010, along the road crossing the forestry base from northeast to southwest, eight square plots of 20 m × 20 m were sampled at sites where *C. simplicifolius* was established. For each plot the borderlines, slope, and aspect were measured using a prismatic compass, and the slope position and support trees were identified by investigators (Table 1). Sampled plots were moderately steep and located at mid slope at elevations of ca. 500 m. East, south, and west aspects were sampled. Seven plots were under *P. caribaea* plantations, only one was under *Acacia mangium* plantation. The frequency of support trees was 453 individuals per hectare.

Table 1. Outline of the plots sampled in the plantations of *C. simplicifolius* in Nanmeiling

Plot	Slope	Aspect	Slope Position	Elevation (m)	Support tree & number
1	20°	Southerly	Middle-upper	492	<i>P. caribaea</i> , 17
2	21°	Southerly	Middle-lower	492	<i>P. caribaea</i> , 21
3	23°	Southerly	Middle-lower	490	<i>P. caribaea</i> , 18
4	21°	Easterly	Middle-upper	501	<i>P. caribaea</i> , 2 <i>A. mangium</i> , 12 other hardwood, 4
5	21°	Southerly	Middle-lower	526	<i>P. caribaea</i> , 19
6	19°	Westerly	Middle-lower	523	<i>P. caribaea</i> , 20
7	20°	Southwesterly	Middle	518	<i>P. caribaea</i> , 16
8	21°	Southerly	Middle-lower	530	<i>P. caribaea</i> , 16

Measurements

Each plot was investigated as follows: the longest stem of a plant

was considered the mother stem, while other stems were considered to be sucker stems. All stems were counted and classified into groups of mother stem or sucker stem, and drying shoot or normal shoot. The stem length of mother stems was measured using a telemeter rod as the distance from the base to the upper point where the petiole of the last frond and folded leaves (leaf blade) met (Nur Supardi et al. 1999). Each stem, if its shoot was drying, was cut transversally using large scissors inch by inch from the exposed part of the last frond downward to the fresh part of the stem. During the course of cutting, symptoms such as holes, tunnels, or presence of fluids were recorded for each shoot.

Trapping of adult weevils

Three pheromone traps produced by Huang et al. (2008) were placed in the plantations of *C. simplicifolius* in Nanmeiling at least 100 m apart from each other on September 27. One was placed on the ground, a second was hung on a mother stem of *C. simplicifolius* and the third was hung on the trunk of a small hardwood tree. After they were placed, each bucket was filled with ca. 5 kg of tap water. They were checked every day till *R. ferrugineus* larvae became adult in the traps.

Each trap consisted of a red plastic bucket base and a cross galvanized iron plank upper. The bucket was nearly cylindrical with a height of c. 40 cm, a round base of c.10 cm and a round upper mouth of c.15 cm. The cross plank was 40 cm long and 30 cm wide. It was fixed to the mouth rim of the bucket by two pieces of galvanized iron wire serving as the handle of the trap.

A pheromone sack was hung ca. 10 cm below the centre of the upper rim of the plank by a piece of wire. The pheromone sack was the Ferrolure+, a product No. P028 manufactured by Chemtica International, S.A., Costa Rica. It contained one unit pheromone and synergist for *R. ferrugineus*, weighing 700 mg. Its active ingredients were 9 parts of 4-methyl-5-nonanol plus one part of 4-methyl-5-nonanone. It was manufactured in February 2010, and its expiry was in February, 2012. Its release rate was 3–10 mg per day.

Identification of the pest

Mature and lively larvae captured in drying shoots and trapped adult weevils were identified by experts on *R. ferrugineus* from the Research Institute for Coconut of the Chinese Academy of Tropical Agriculture.

Data analysis

The percentages of shoot drying for mother stems and sucker stems were calculated as Equ. 1:

$$\text{The percentages of shoot drying} = \frac{NDS}{NTS} \times 100 \quad (1)$$

Where, NDS stands for the number of mother stems or sucker stems whose shoots were drying, NTS for the total number of

mother stems or sucker stems accordingly.

The frequency of stem was calculated as Equ. 2:

$$\text{The frequency of stem} = \frac{NS \times 10000}{400} \quad (2)$$

Where, NS means the number of stem, the numbers 10 000 and 400 represent the number of square meters in a hectare and a plot.

Data were analyzed using the Chi-square test running on Forstat 2.0 produced by the Chinese Academy of Forestry. Statistical significance between mother stem and sucker stem was tested by the sign test.

Results and discussion

Percentages of shoot drying

The percentages of shoot drying varied from 18.9% to 33.8% (Table 2). This percentage was higher than the 2.5% reported for *C. merillii* by Braza (1988), indicating that shoot drying was a serious problem in the plantations of *C. simplicifolius*. The frequency of mother stems was significantly less than that of sucker stems, whereas, the percentage of shoot drying was insignificantly higher in mother stems than in sucker stems. Therefore, more attention should be paid to identifying the cause of shoot drying in sucker stems.

Impact of shoot drying on the stem length of mother stem

The average length of mother stems of normal shoots was 3.9 m, while that of mother stems of drying shoots was 1.9 m (c. 2 m shorter). The difference was significant, indicating that stem

growth of drying shoots was retarded.

Table 2. Frequency of stem and percentage of shoot drying of *C. simplicifolius*

Stem type	Frequency of stem (stems·ha ⁻¹)	Percentage of shoot drying (%)
Mother stem	259±45*	33.8±8.3*
Sucker stem	588±128	18.9±6.7
Mean	597±121	27.5±4.4

*Means±M.S.D

The cause of shoot drying

According to above results, the cause of shoot drying in *C. simplicifolius* is proposed to attribute to infestation by the Red Palm Weevil, *R. ferrugineus*. At least one of the symptoms, viz. holes, discharge of fluids, chewed fibres, young larvae, mature larvae, and/or black tunnels was found in the drying shoots and enclosing sheaths. Using this information we could explain the cause of shoot drying: The female weevil deposits eggs on sheaths enclosing a shoot and the hatching larvae initially feed on the sheaths. At this stage, water is normally transported to supply the folding leaves of the shoot as the vessels in the shoot are intact. As the larvae bore into the shoot, the shoot remains intact but exudes viscous liquid. Presence of the liquid indicates water transportation to the folding leaves is deterred because the vessels have been destroyed by the larvae. The folded leaves begin drying because of the shortage of water supply. Mature lively larvae caught in drying shoots and the adults trapped in the plantation are shown in Fig. 2. They were identified as the Red Palm Weevil. Thus the Red Palm Weevil is proved to be the probable reason of shoot drying in *C. simplicifolius*.

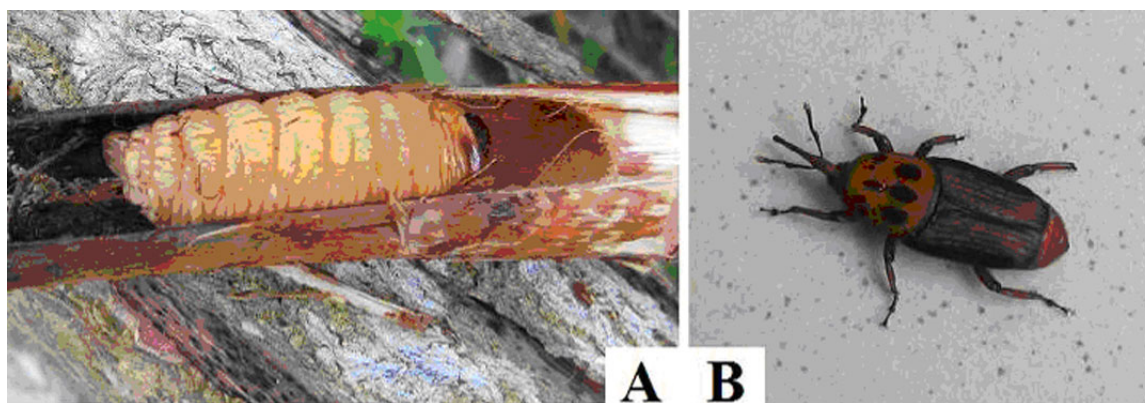


Fig. 2 Mature larvae captured in drying stems and adult weevils trapped in plantations. (A) Mature larva in rattan shoot. (B) Adult weevil trapped

Conclusions

Although *C. simplicifolius* has spines that contribute some degree of protection from some pests, it lacks defense mechanisms against attack by the Red Palm Weevil. Near 30% of shoot drying shows the weevil is a serious pest for *C. simplicifolius*. The

impact of shoot drying on the stem length of mother stems means that cane production is reduced by at least 50%. Therefore, it is strongly recommended to control such a serious weevil infestation. Different control methods have been investigated including physical, biological, mechanical and chemical control (Abbas et al. 2000; Faleiro and Satarkar 2002; Gindin et al. 2006; Muthiah et al. 2005; Ramachandran 2005; Soroker et al. 2004). Integrated

pest management of RPW in date palm plantations proposed by Abbas et al. (2006) could be applied in the rattan plantations.

Acknowledgements

We are grateful to SUN Cheng-xun, HUANG Shan-chun and LI Chao-xun from the Research Institute for Coconut of the Chinese Academy for Tropical Agriculture for supplying the pheromone and trap and identification, HUANG Shi-neng from the Research Institute of Tropical Forestry of the Chinese Academy of Forestry for providing cutting tools.

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